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(54) Removing noise signals from video signals

(57) Removing noise signals from video signals by means of adaptive median filtering is proposed, with the object of masking errors in large-size disturbed picture areas caused by dirt and dust during scanning of the film. To accomplish this the picture content is always classified in stationary, moving, undisturbed and disturbed picture areas, and the error masking is effected by means of temporal median filtering in only the disturbed and stationary picture areas.

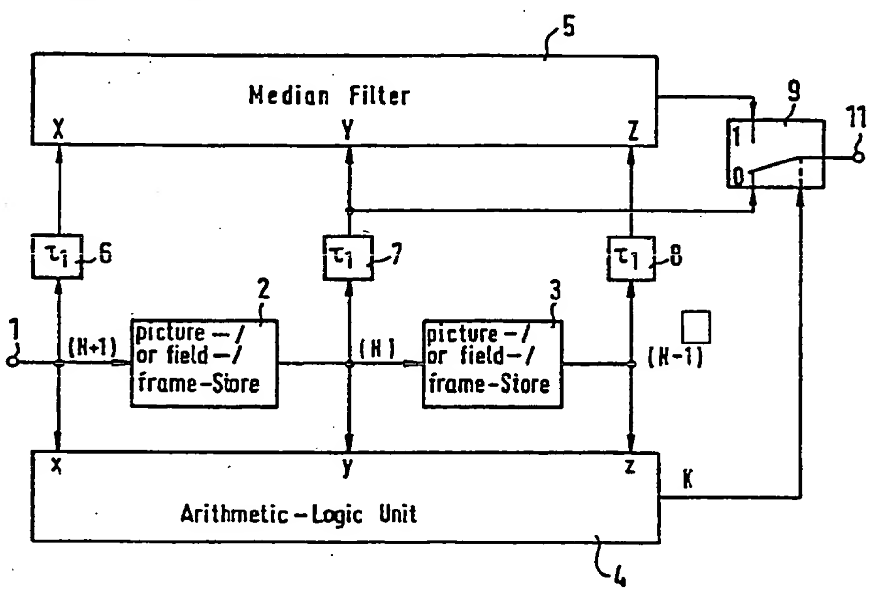

FIG. 1

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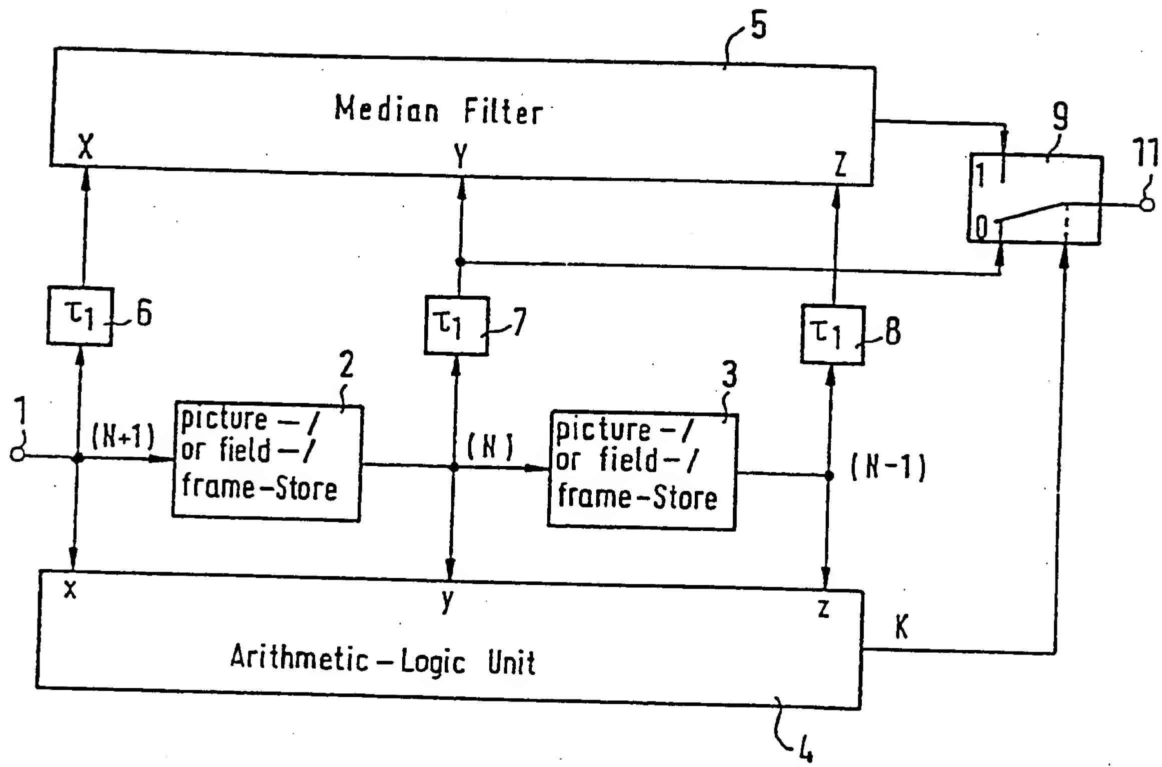

5
Median Filter
X
Y
Z
9
11
1
0
τ1
6
τ1
7
τ1
8
2
3
1
(N+1)
picture –/
or field –/
frame–Store
(N)
picture –/
or field –/
frame–Store
(N-1)
x
y
z
K
Arithmetic – Logic Unit
4

FIG. 1

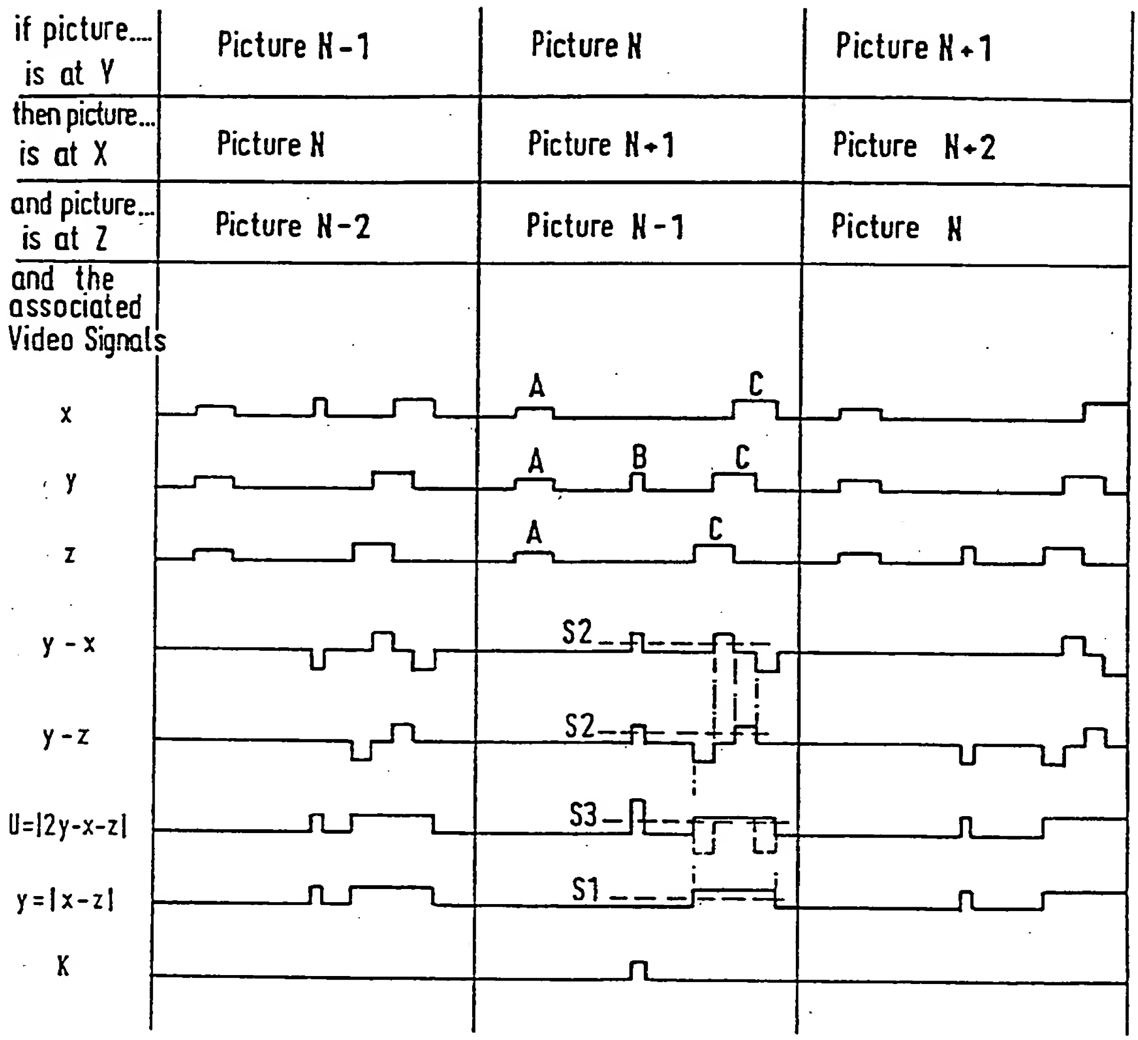
if picture.... is at Y
Picture N-1
Picture N
Picture N+1
then picture... is at X
Picture N
Picture N+1
Picture N+2
and picture... is at Z
Picture N-2
Picture N-1
Picture N
and the associated Video Signals
x
y
z
y - x
y - z
U=|2y-x-z|
y=|x-z|
K
A
B
C
S2
S3
S1

FIG. 2

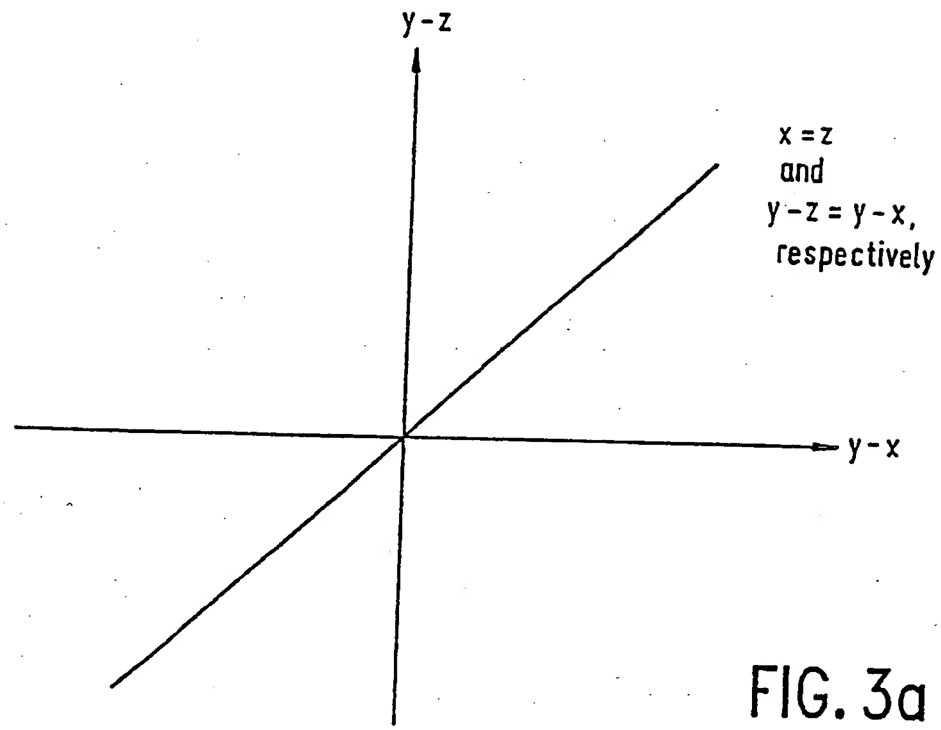
y - z
x = z
and
y - z = y - x,
respectively
y - x

FIG. 3a

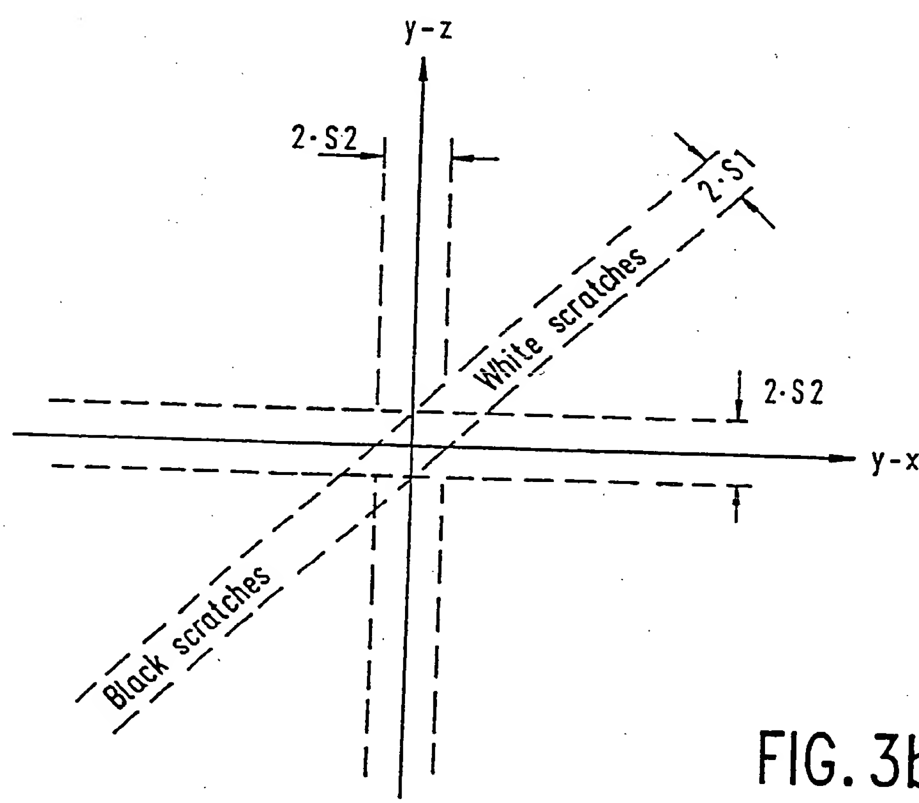
y - z
2·S2
2·S1
White scratches
2·S2
y - x
Black scratches

FIG. 3b

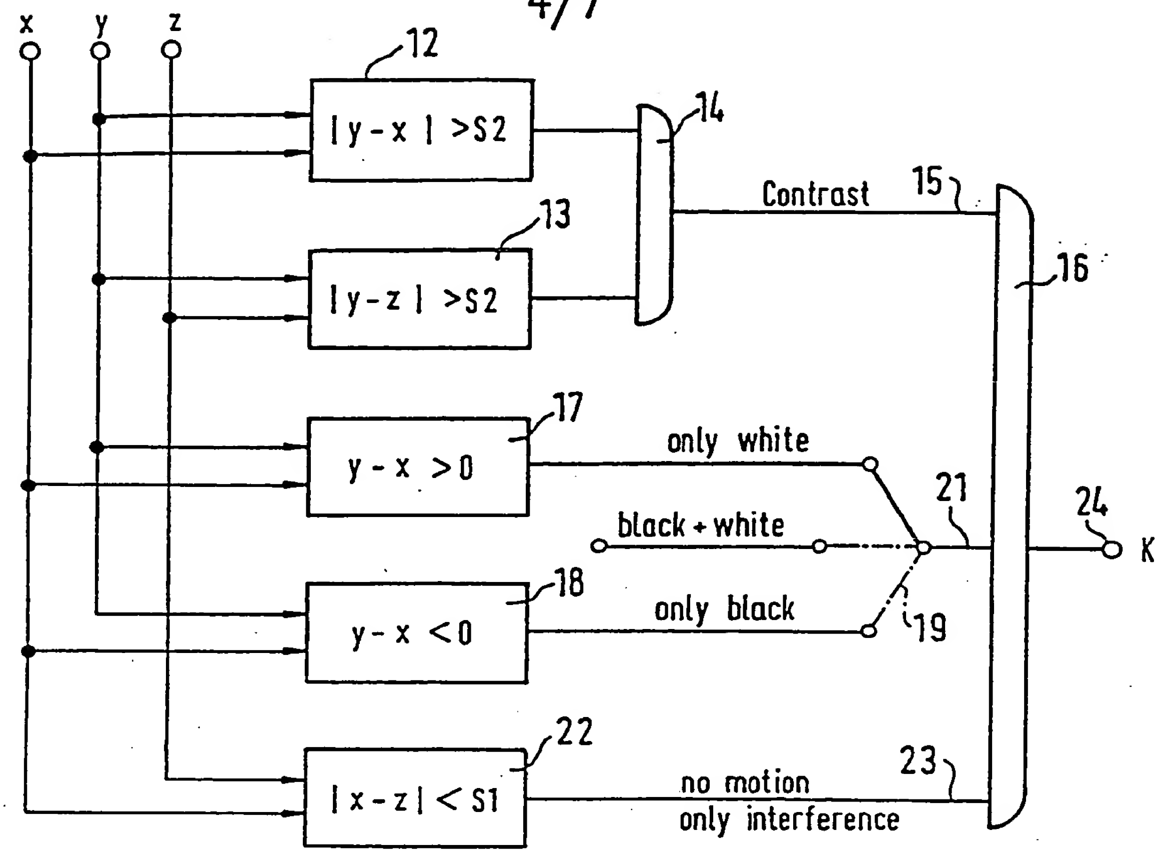
x
y
z
12
|y-x| >S2
14
13
|y-z| >S2
Contrast
15
16
17
y-x >0
only white
black+white
21
24
K
18
y-x <0
only black
19
22
|x-z| < S1
no motion
only interference
23

FIG. 4a

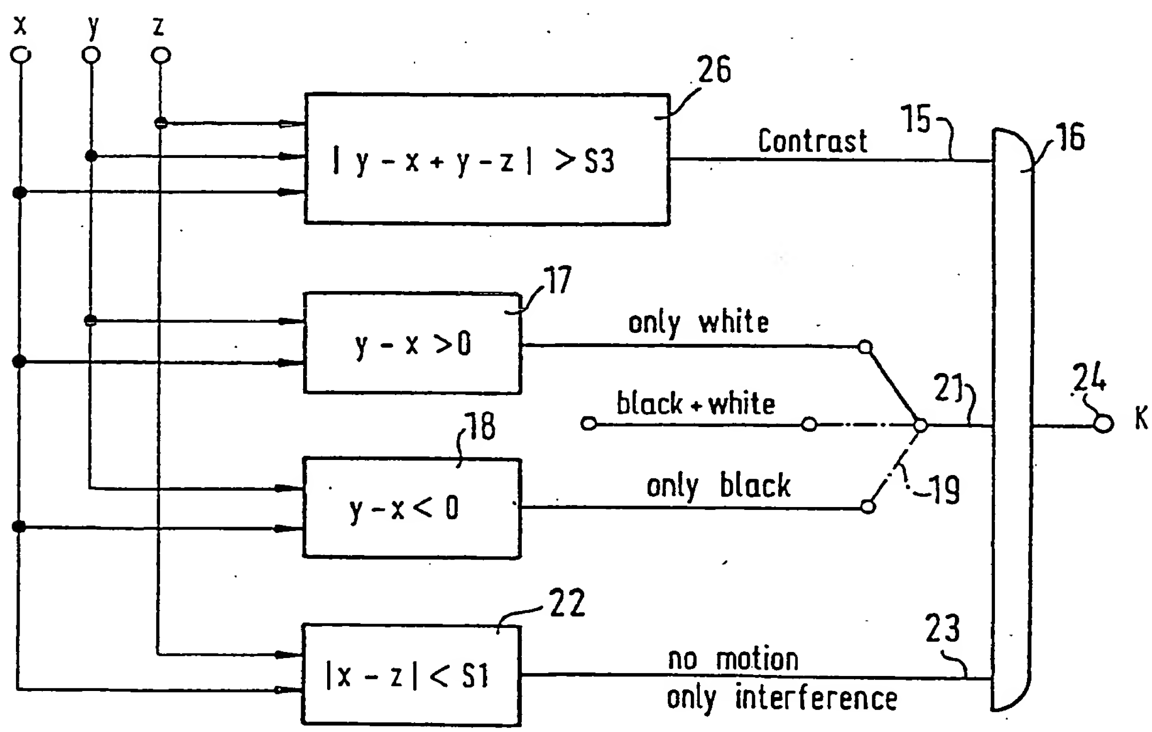
x
y
z
26
|y-x+y-z| >S3
Contrast
15
16
17
y-x >0
only white
black+white
21
24
K
18
y-x< 0
only black
19
22
|x-z|< S1
no motion
only interference
23

FIG. 4b

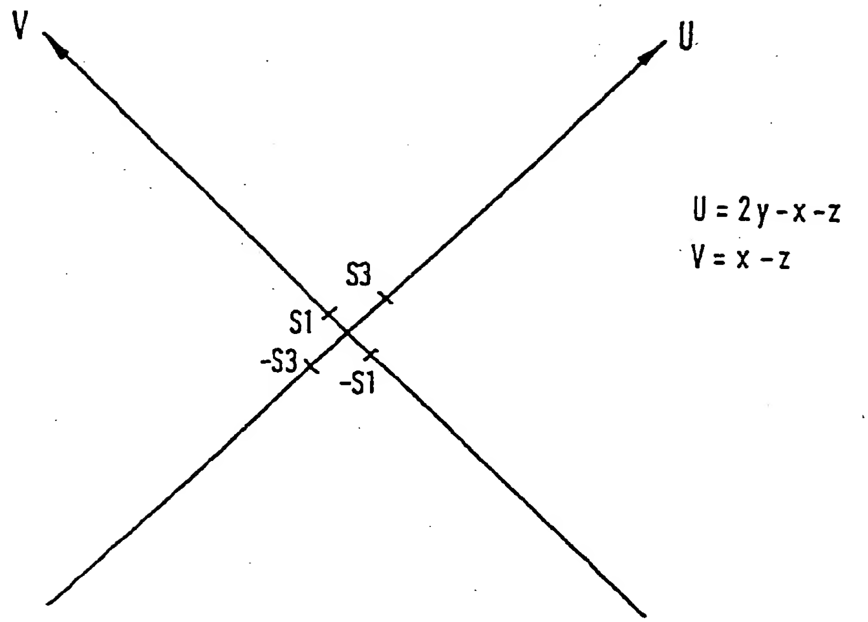
V
U
S3
S1
-S3
-S1
U = 2y - x - z
V = x - z

FIG. 5a

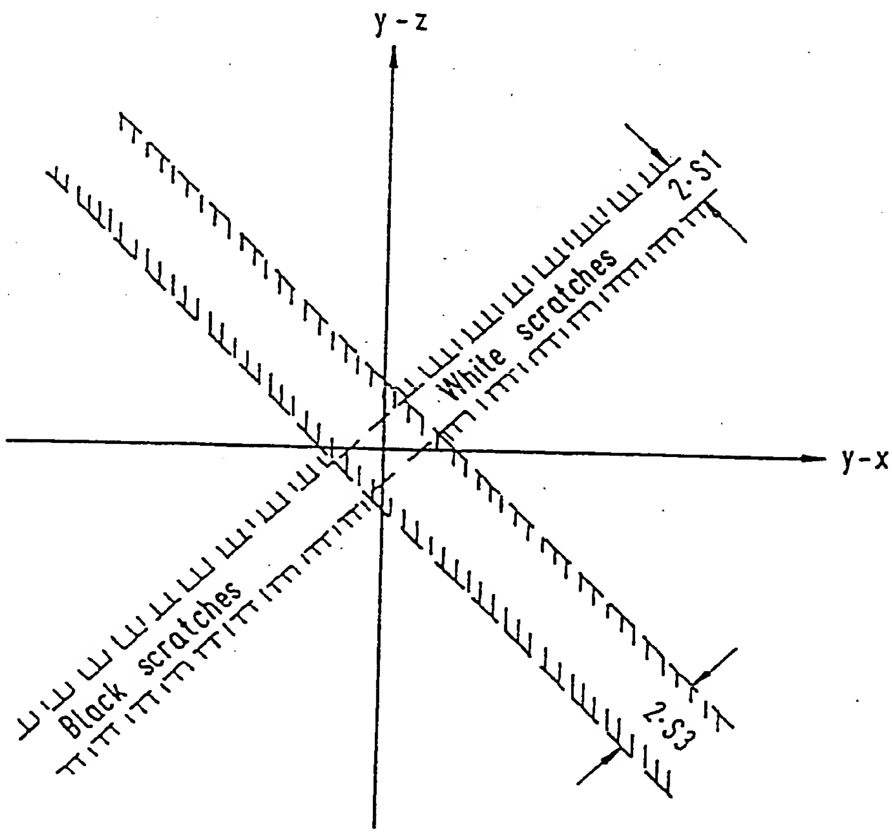
y - z
y - x
White scratches
Black scratches
2·S1
2·S3

FIG. 5b

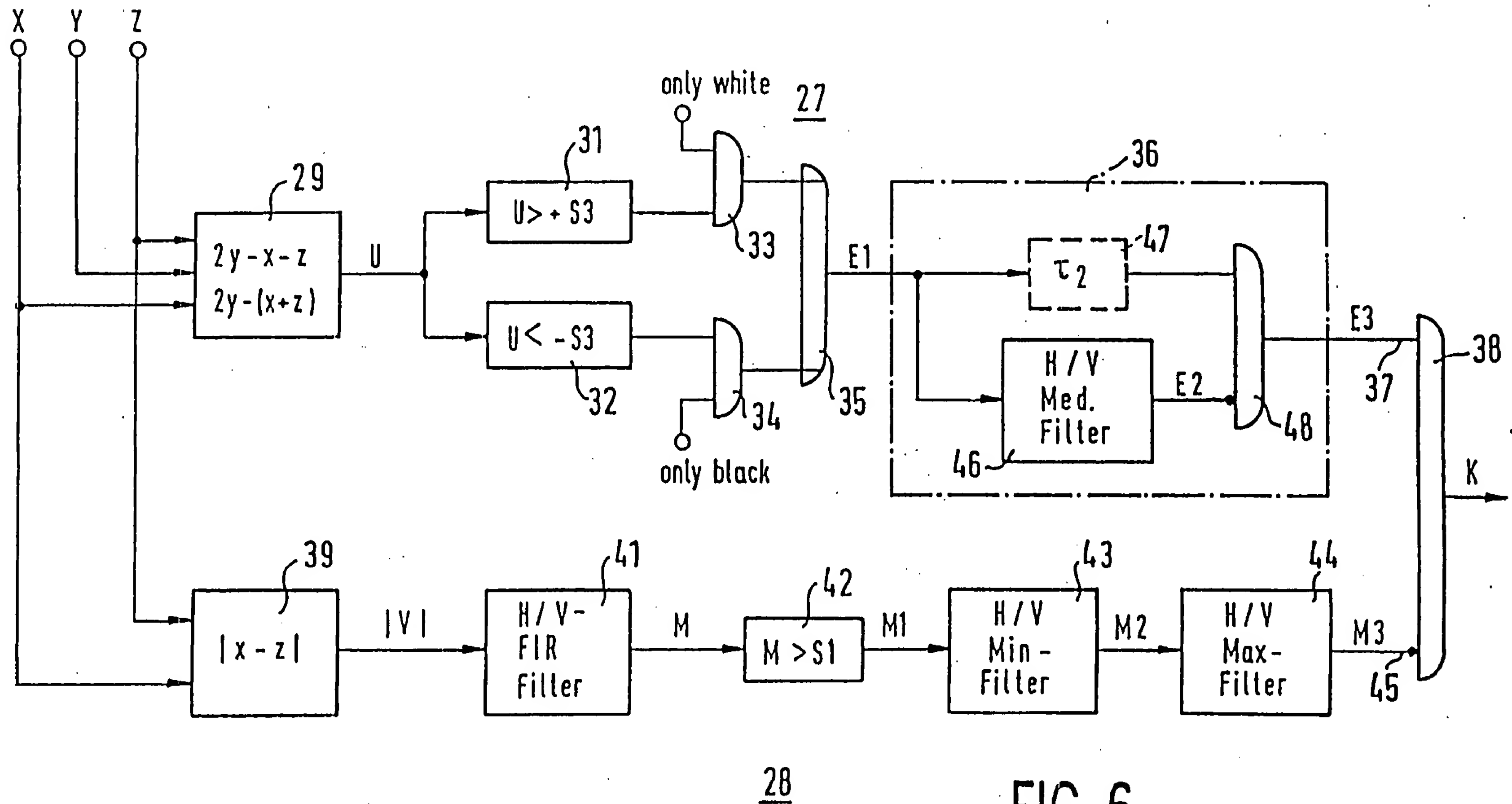
X
Y
Z
29
2y-x-z
2y-(x+z)
U
31
U>+S3
U<-S3
32
only white
only black
27
33
34
35
E1
36
47
τ_2
H/V
Med.
Filter
46
E2
48
E3
37
38
K
39
|x-z|
|V|
41
H/V-
FIR
Filter
M
42
M>S1
M1
43
H/V
Min-
Filter
M2
44
H/V
Max-
Filter
M3
45
28

FIG. 6

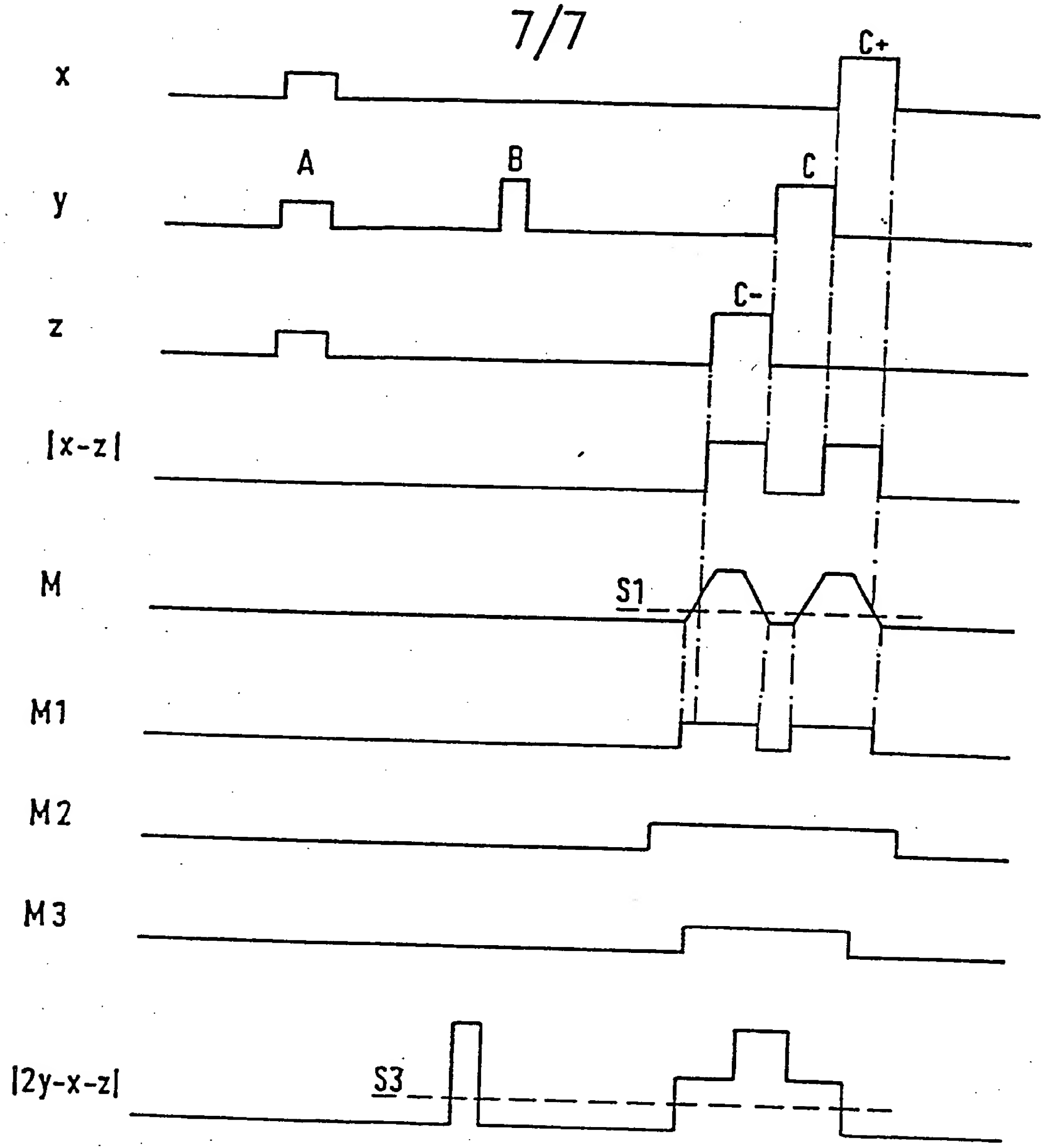

FIG.7

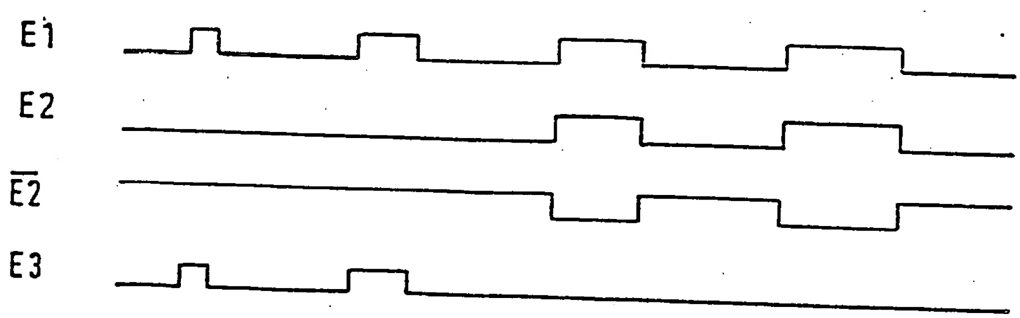

FIG. 8

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DESCRIPTION

REMOVING NOISE SIGNALS FROM VIDEO SIGNALS

The invention relates to a method of and a circuit for removing noise signals from video signals by means of adaptive median filtering.

The German patent application P 43 26 390.9 corresponding to US Appln. Serial No. 08/285,268 (Atty. docket PHD 93-105) proposes a method of removing noise signals from video signals by means of a motion adaptive filtering, in which uniformly distributed noise as well as also pulse noise is reduced.

In addition, the DE 40 14 971 A1 corresponding to UK Patent Appln. No. 9110054.5 (PHD 90-246 GB) discloses a circuit arrangement for median filtering of video signals produced during scanning of a film, by means of which interferences due to dust and scratches is reduced.

Characteristic of the said interferences and of the efficiency of the method described is a limited local expansion of the interference to a few related picture elements, to one line at a maximum.

An object of the present invention is to enable the provision of a method of and a circuit for removing noise signals from video signals, using which it is possible to mask errors of very large-sized disturbed picture areas, for example due to excessively stained or highly scratched films.

The invention provides a method of removing noise signals from video signals by means of adaptive median filtering, characterized in that the picture content is always classified in stationary, moving, undisturbed and disturbed picture areas and that contiguous thereto error masking by means of temporal median filtering is only effected in the disturbed and stationary picture areas.

The method according to the invention has the advantage, of enabling large-sized interferences in stationary picture areas of films be suppressed without large extra costs or design efforts.

The measures defined in the sub-claims enable advantageous further developments and improvements of the method claimed in Claim 1. Further sub-claims describe an advantageous circuit for putting the method in accordance with the invention into effect.

An embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a block circuit diagram for putting the method of the invention into effect,

Figure 2 shows a time diagram for deriving control signals,

Figures 3a, 3b are graphical representations of the picture interferences in a system of coordinates,

Figures 4a, 4b are block circuit diagrams of two alternative arithmetic-logic units,

Figures 5a, 5b are graphic representations of picture interferences in a further system of coordinates,

Figure 6 is a block circuit diagram of a further arithmetic-logic unit,

Figure 7 shows a time diagram of the signals shown in Figure 6,

Figure 8 shows a time diagram of the signals present in the pulse width-discriminator of Figure 6.

Corresponding components in the Figures have been given the same references.

In the block circuit diagram shown in Figure 1 of apparatus for putting the method in accordance with the invention into effect, a digital video signal (luminance and/or chrominance signal) which is preferably derived during film scan, is applied via a terminal 1 to two series-arranged (frame or field) picture stores 2, 3, so that three consecutive pictures N-1, N, N+1 are simultaneously available. The video signals x, y, z of these three pictures are now applied on the one hand to the inputs X, Y, Z of an arithmetic-logic unit 4 for producing a control signal K and on the other hand to the inputs X, Y, Z of a median filter 5, each via a delay section 6, 7, 8 for propagation time matching to the control signal K. If the picture at the input Y is

considered to be the actual picture N, then at the input Z of the preceding picture N-1 and at the input X the subsequent picture N+1 are available.

The output of the median filter 5 is connected to one input of a change-over switch 9, at whose other input the video signal Y of the picture N is present. The change-over switch 9 is switched by means of the control or switching signal K, which is produced in the arithmetic-logic unit 4 and is available at its output. In the arithmetic-logic unit 4 a classification of the picture content of the three simultaneously available pictures in moving, stationary, disturbed and undisturbed picture areas and a switching signal K is only produced for the disturbed and stationary picture areas. Thereby the switch 9 is switched in such a manner that, after median filtering, in only the disturbed and stationary areas of the picture N the input signal arrives at the output 11, whilst for all the other picture areas the signal Y of the picture N is directly conveyed to the output 11. It is of course a condition for the function of error masking by the median filter 5 that the neighbouring pictures N-1 and N+1 are in this position free from errors.

The classification of the picture content for deriving the control signal K will now be described with reference to Figure 2. Let the picture content be characterized by the objects A, B and C. Object A comprises all the quiescent picture details, object B represents a disturbed picture area, which only occurs in picture N, and object C defines a picture portion moving from left to right.

In order to establish the differences between the pictures, the differences in the video signals y-x and y-z are computed. The amount of the differences is considered, as described in the patent application P 43 26 390.9 corresponding to US Appln. Serial No. 08/285,268 (Atty. docket PHD 93-105), to be a motional signal and is used for controlling (switching off) the median filter, so as to prevent motional streaking. It then happens that the object B, i.e. the interference in the picture N is also mis-interpreted as motion and that the median filter would be switched off.

It is however an object of the method according to the invention to

energize the median filtering operation precisely in this case. Therefore, a criterion to distinguish between object B (interference) and C (motion) is required. A feature of the interference is that the object B occurs non-recurrently in the picture N. This results in for the picture N it holds that for the two differential signals y-x and y-z y-x = y-z or x = z respectively. This can be interpreted as follows: when a non-recurrent interference occurs in the picture N, the two motion detectors respond to the same extent, and there is no difference between picture N-1 and picture N+1, that is to say x-z = 0.

Figure 3a illustrates this fact graphically. All the singular picture interferences are located on a 45°-straight line in a system of coordinates, at which y-z is plotted against y-x. Since there is in practice always a certain noise component superimposed on real picture signals, the difference between the pictures N-1 and N+1 will not be accurately equal to zero. It is therefore convenient, to define, instead of the strict straight scratch line a tolerance area by |x-z| < S1. The threshold value S1 is determined by the peak value of the noise amplitude to be expected and can be set externally or automatically, as is, for example, described in German patent application P 43 19 343.9, corresponding to US Appln. Serial No. 08/252,507 (Atty. docket PHD 93-083).

This tolerance range is shown in Figure 3b. White scratches are located in the first quadrant of the coordinate system, whereas the black scratches are located in the third quadrant. The distinguishing feature may, for example, be the sign of the difference y-x. In the environment of the origin of the coordinates the tolerance field defined by S1 does not provide a sharp criterion for interferences, as here all the stationary or slightly mobile picture areas, respectively, are shown. For this reason a second condition is added, namely both differential signals y-x and y-z must have a value greater than S2. Graphically

this means that a noise signal must have a given lowest contrast S2, to be recognizable as such.

Figure 4a shows a circuit for an arithmetic-logic unit for deriving the control signal K. The following three conditions can be formulated:

1. Contrast condition wherein $|y-x| > S2$ and $|y-z| > S2$,
2. Detection of white or black noise wherein $y-x > 0$ or $y-x < 0$,
3. Difference between noise and motion wherein

a) $|x-z| < S1$ means noise, no motion (consequently the control signal K is delivered),

b) $|x-z| > S1$ means no noise, but motion.

The median value of the video signals is only then switched to the output 11 by means of the control signal K when the conditions 1., 2. and 3.a) are satisfied.

The circuit of the arithmetic-logic unit 4 therefore consists of first and second comparator circuits 12 and 13, whose inputs are connected to the input and to the output of the first picture store 2 and to the input and to the output of the second picture store 3, respectively. In this situation, according to the differential value and absolute value formation of the input signals applied, a comparison to the threshold value S2 takes place, a signal then being supplied only when this threshold value S2 is exceeded. The outputs of the comparator circuits 12 and 13 are connected to the inputs of an AND-circuit 14, whose output is connected to the first input 15 of a further AND-circuit 16.

Third and a fourth comparator circuits 17 and 18 are connected to the input and to the output of the first picture store 2. In the comparator circuits 17 and 18 a differential signal y-x is formed, the comparator circuit 17 then supplying a signal when the differential value exceeds zero and the comparator circuit 18 then

supplying a signal when the differential value is less than zero. These so-called identification signals "white" or "black", respectively, are supplied in the event of white or black scratches, respectively. In the case of a black or a white scratch, a logic one is formed at one of the inputs of a change-over switch 19. This change-over switch 19 then transfers the signal corresponding to the interference to the second input 21 of the further AND-circuit 16.

A fifth comparator circuit 22 is connected to the input of the first picture store 2 and to the output of the second picture store 3, respectively, a comparison to the threshold value S1 being effected after the differential value and the absolute value of the signals x and z have been formed. In this situation a signal is only supplied when this threshold value S1 is not reached. The output of this fifth comparator circuit 22 is connected to the third input 23 of the further AND-circuit 16. A control signal K can only be taken from the output 24 of this AND-circuit 16 when a logic one is present at each of the three inputs 15, 21 and 23.

Figure 4b shows a circuit of the arithmetic-logic unit 4 with an alternative contrast condition: $|y-x+y-z| > S3$ instead of the first contrast condition in accordance with Figure 4a). Instead of the comparator circuits 12 and 13 a comparator circuit 26 is used in Figure 4a), whose inputs are connected to the inputs of the first picture store 2 and of the second picture store 3, as well as to the output of the second picture store 3, for which reference is also made to the corresponding timing diagram in Figure 2.

The Figures 5a and 5b are a graphical interpretation thereof. The threshold values S1 and S3 define tolerance fields which are located in a system of coordinates U, V which are rotated through 45° and extend parallel to the axis. For the rotated coordinates the following transformation equations apply: U = 2y-x-

z and V = x-z.

The circuit of Figure 4b has the advantage that using the contrast condition |2y-x-z| > S3 or |U| > S3, respectively, the interference (object B) versus the motion (object C) is reduced to a greater extent, as can be seen from the timing diagram shown in Figure 2. It is also easy to see from this timing diagram that the control signal K only changes to logic one in the case where:

S1 is not exceeded, consequently no motion and

S2 is exceeded (contrast condition) or

S3 is exceeded (alternative contrast condition), respectively.

Figure 6 shows an alternative circuit for producing the control signal K, which is based on the principle of the circuit shown in Figure 4b, i.e. the signal processing is effected in the rotated U/V-system of coordinates. This has the advantage that the U-signal basically contains the noise signal components, whilst the V-signal basically contains the motional components. An additional dual channel signal processing for U and V has for its aim to separate the components noise and motion to a still better extent from each other and to remove unwanted noise components from them.

During processing of the U-signal in the upper signal channel there is first provided a circuit for forming the differential value 29, whose inputs are connected to the inputs and outputs x, y, z, respectively, of the picture stores 2, 3, whereafter, after the differential values between the output and input signals y-x of the first picture store 2 and between the input and output signals y-z of the second picture store 3 have been formed, the differential values are added together. The output of this circuit 29 is connected to each of the inputs of two comparator circuits 31, 32, in which a comparison of the output signal U of the circuit 29 for forming the differential value to the positive value or the negative value, respectively, of the threshold value S3 is

performed and a signal is supplied only then when the always positive or negative value, respectively, of the threshold value S3 is exceeded or not reached respectively.

The outputs of the comparator circuits 31, 32 are each connected to an input of two AND-circuits 33, 34, which serve as gate circuits. To that end, a control signal "only white" or "only black", respectively, is always applied to the second inputs of the AND-circuits 33, 34. If both black and white scratches are detected, both control signals have logic value one. The outputs of the AND-circuits 33, 34 are each connected to an input of an OR-circuit 35, whose output is connected via a pulse-width discriminator 36 to the first input 37 of a further AND-circuit 38.

For processing the V-signal in the lower channel 28 there is first provided a circuit 39 for forming the differential value and the absolute value, whose inputs are connected to the input of the first picture store 2 and to the output of the second picture store 3. Consequently the difference between the signal x and the signal z is formed in the circuit 39 and thereafter its absolute value, so that a signal $|V|$ can be taken from the output of the circuit 39. The $|V|$-signal is applied via a subsequent H/V-transversal filter 41, which acts as a low-pass filter, as signal M to a comparator circuit 42, wherein a comparison to the threshold value S1 is effected and a signal M1 is supplied only when this threshold value is exceeded. The output signal M1 is applied via a H/V-min-filter 43 for the purpose of signal expansion and a H/V-max-filter 44 for the purpose of signal compression to the inverting input 45 of the AND-circuit 38, from whose output the control signal K can be taken.

As has already been mentioned in the foregoing, the interferences are mapped in the ideal case on the straight line $x = z$, i.e. $V = x\text{-}z = 0$ is located on the U-axis. Because of noise superimposed thereon, the V-component is not accurately equal to zero, for which reason the tolerance field having a width 2 S1 had to be inserted. By a bi-dimensional low-pass filtering of the V-components in the horizontal and the vertical

direction by means of the filter 41, it is possible to decrease the required threshold value S1 to a significant extent, so as to obtain thereby an improved selectivity for the noise components. For this purpose it is sufficient to simply form a mean value over approximately three lines and seven picture elements.

Contrary to the circuit shown in Figure 4b, the subsequent comparator circuit 42 checks whether the filtered signal |x-z| is higher than the adjusted threshold value S1. If so, then accordingly there is no interference, only motion. The preceding low-pass filtration has the side effect, that the motional signal is expanded. The advantage this provides will be explained with reference to the timing diagrams of Figure 7.

Figure 7 shows the three objects A (quiescent picture content), B (disturbed picture content) and C (mobile picture content). In contradistinction to Figure 2, the object C now moves very rapidly. This results in the motional signal |x-z| having a gap in its centre. Without further measures the fast-moving object C would erroneously be interpreted as being an interference and would consequently be filtered out. By expanding the motional signal with the aid of the low-pass filter 41, the gap is already reduced to some extent, as can be seen from signal M1. The motional signal M1 may be expanded still further, by the H/V-min-filter 43. The min-filter 43 projects from a bi-dimensional window, formed by a series of picture elements and lines, its minimum input value at the output. Since the input signal M1 only consists of one bit, the min-function represents a simple OR-operation on the values of the filter window. The size of the window depends on the maximum motional speed of the mobile objects or on the maximum shift from one picture to the next but one picture.

On film reproduction this value is twice as high as with video signals, because of the low picture recording frequency of 24 frames/s. In practical tests a filter window of approximately 5 lines * 21 picture elements proved to be sufficient for film reproduction. As horizontal motion generally dominates and for example due to moving of the camera occurs much more

often, this explains the comparatively small vertical filtering over only 5 lines.

In the processing of video signals the filter window may be reduced to 3 lines * 11 picture elements. It is however a condition that simultaneously the picture delay members 2, 3 for the generation of three video signals x, y, z are switched over from frame delay to field delay. These window sizes are given on the basis of conducted tests but are not limitative as other sizes may be appropriate for particular picture content.

Figure 7 shows at the signal M2 how in this manner the gap in the motional signal is closed. It shows also the significant widening of the motional signal, which extends far outside the range of the object C. This unwanted signal expansion is eliminated by the subsequent H/V-max-filter 44, but the gap remains closed. The max-filter 44 represents a logic AND-operation on the input signal via a bi-dimensional field. The filter window can be chosen slightly greater compared with the preceding min-filtering, to also contribute to compensating for the expansion of the motional signal by the low-pass filter 41. The motional signal M3 thus obtained is used with the opposite polarity as an enable signal for the upper signal channel 27.

When the arithmetic-logic unit described in Figure 6 is used, disturbed picture areas of any optional size can be replaced. In the extreme case a single black picture in a sequence of white pictures can be completely suppressed. This is, however, not normally necessary in actual practice. The interferences generally extend over a limited number of associated picture elements and, depending on the cause, have each a given local effect. This may be purely in the horizontal direction (drop-out of picture elements, high-frequency pulses, clamping interferences) or only in the vertical direction (film-run scratches) but may also be planar (film dust, film dirt). It is therefore good policy to limit the noise signal E1 to the anticipated size, using the pulse-width discriminator 36 shown in Figure 6. Thus an inadvertent triggering of the control signal K by a very rapidly moving object C over a large area can be prevented cf. the signal |2y-x-z|

in Figure 7.

Figure 8 illustrates on the basis of a timing diagram the principle of such a suppression circuit (for the sake of simplicity only in the horizontal direction). A median filter 46 acts in the example over 5 picture elements. That is to say, it supplies from its output a signal only then when at the input more than half the number of picture elements, consequently at least 3 picture elements, have logic one value. The signal sequence E2 may be interpreted as a low-pass filtered version of the input signal E1, as only the low frequency (wide) pulses are transferred by the median filter. In order to obtain a high-pass filtered version of the input signal sequence, in which the wide pulses are suppressed, the output signal E2 of the median filter 46 is subtracted from the input signal E1. Since the signals E1 and E2 are binary signals, the subtraction can be represented by means of an AND-operation E1 & !E2 which can be performed by an AND-circuit 48.

So as to realize the bi-dimensional discriminator 36 the filter window of the median filter 46 must be adjustable to a maximum size of 9 lines * 21 picture elements, in order to suppress the most significant interferences which may be anticipated in actual practice. A further four completely disturbed lines can, for example, be restored therewith, or perpendicularly extending interferences up to 10 picture elements wide or planar interferences which extend over a total of 94 picture elements. For less serious interferences the filter window can be reduced stepwise, for example to 7 lines * 15 picture elements, 5 lines * 11 picture elements or 3 lines * 7 picture elements. Also other combinations can be suitable, for example 5 lines * 1 picture element, when the input signal has horizontal clamping interferences of a width of two lines. For the case in which extremely large-sized picture interferences are yet to be processed, it must be possible to switch the pulse-width discriminator 36 completely off, it then holding that E3 = E1. For the AND-operation of the signals E1 and E2 a delay time matching T2 corresponding to the transit time delay of the median filter 46 is required, for which the delay member 47 is provided.

Likewise the signals E3 and M3 for generating the control signal K must have equal transit times.

From reading the present disclosure, other modifications will be apparent to persons skilled in the art. such modifications may involve other features which are already known in the design and use of circuits for reducing noise in video signals and components parts thereof and which may be used instead of or in addition to features already described herein. Although claims have been formulated in this application to particular combinations of features, it should be understood that the scope of the disclosure of the present application also includes any novel feature or any novel combination of features disclosed herein either explicitly or implicitly or any generalisation of one or more of those features which would be obvious to persons skilled in the art, whether or not it relates to the same invention as presently claimed in any claim and whether or not it mitigates any or all of the same technical problems as does the present invention. The applicants hereby give notice that new claims may be formulated to such features and/or combinations of such features during the prosecution of the present applicaiton or of any further application derived therefrom.

CLAIMS

1. A method of removing noise signals from video signals by means of adaptive median filtering, characterized in that the picture content is always classified in stationary, moving, undisturbed and disturbed picture areas and that contiguous thereto error masking by means of temporal median filtering is only effected in the disturbed and stationary picture areas.

2. A method as claimed in Claim 1, in which from the simultaneously available video signals of at least three time-sequential pictures a control signal is derived, and that with the aid thereof either only the video signals which are derived from the disturbed and stationary picture areas and have been filtered by the median filter or the video signals which are derived from the undisturbed, moving or stationary and the disturbed, moving picture areas and which are not filtered are conveyed further.

3. A method as claimed in Claim 2, in the control signal is a switching signal for switching between the median-filtered and the unfiltered video signals.

4. A method as claimed in Claims 2 and 3, in which for deriving the switching signal the following conditions must simultaneously have been satisfied:

$|y-x| > S2$, $|y-z| > S2$, $|y-x| > 0$ or $|x-y| < 0$, $|x-z| < S1$, wherein x, y, z indicate the video signals derived from the three pictures, and S1 and S2 each indicate an adjustable threshold value.

5. A method as claimed in Claims 2 and 3, in which for deriving the switching signal the following conditions must simultaneously be satisfied:

$u = |2y-x-z| > S3$, $v = |x-z| < S1$, wherein x, y, z indicate the video signals derived from the three pictures, and S3 and S2 each indicate an adjustable

threshold value.

6. A circuit for performing the method as claimed in Claims 1 to 3, comprising at least two picture stores at whose outputs the picture-sequentially delayed video signals are available, wherein each input or output, respectively, of the picture stores is connected to each one of inputs of an arithmetic-logic unit and also to each one of inputs of a median filter, the output of the median filter is connected to one input of a change-over switch to whose other input the picture-sequentially delayed video signal is applied, and the output of the arithmetic-logic unit from which the switching signal is supplied is connected to the control input of the change-over switch.

7. A circuit for performing the method claimed in Claim 4 comprising an arithmetic-logic unit with a first and a second comparator circuit whose inputs are connected to the input and to the output of the first picture store and to the input and the output of the second picture store respectively, for forming differential and the absolute values for comparison to a first threshold value and supplying a signal when this threshold value is exceeded, the outputs of the first and second comparator circuits being connected to the inputs of an AND-circuit whose output is connected to the first input of a further AND-circuit, third and a fourth comparator circuits whose inputs are connected to the input and to the output of the first picture store for determining the differential value and producing an identification signal "WHITE" for a differential value greater than zero or an identification signal "BLACK" for a differential value less than zero, said identification signal being applied to the second input of the further AND-circuit, a fifth comparator circuit, whose inputs are connected to the input of the first picture store and to the output of the second picture store, for forming differential and absolute values for comparison with a second threshold value and producing a signal when this threshold value is not reached, the output of this fifth comparator circuit being connected to the third input of the

further AND-circuit, so that at the output of this AND-circuit a switching signal is available, when a signal is present at each one of three inputs.

8. A circuit for performing the method claimed in Claim 5 comprising an arithmetic-logic unit which comprises a first comparator circuit, whose inputs are connected to the inputs and outputs, respectively, of two picture stores, for forming the differential value between the output and the input signal of the first picture store and between the input and the output signal of the second picture store and adding the differential values together, as well as forming of the absolute value of the sum values, comparing to a third threshold value, and supplying a signal only when this threshold value is exceeded, the output of this first comparator circuit being connected to the first input of an AND-circuit, a second and a third comparator circuit, whose inputs are connected to the input and to the output of the first picture store, for forming the differential value and supplying an identification signal "WHITE" for a differential value greater than zero and an identification signal "BLACK" for a differential value less than zero, respectively, said signal being applied to the second input of the AND-circuit, a fourth comparator circuit, whose inputs are connected to the input of the first picture store and to the output of the second picture store, for forming the differential value and the absolute value for comparison with a second threshold value and supplying a signal only then when this threshold value is not reached, the output of this fourth comparator circuit being connected to the third input of the AND-circuit so that at the output of this AND-circuit a switching signal is available when a signal is present at each one of three inputs

9. A circuit as claimed in Claim 6, in which the arithmetic-logic unit is provided with a circuit for forming the differential value, whose inputs are connected to the inputs and outputs, respectively, of the picture stores whilst after the differential value between the output and the input signal of

the first picture store and between the input and the output signal of the second picture store has been formed the differentiai values are added together, the output of this circuit being connected to each input of two comparator circuits in which a comparison of the output signal of the circuit for forming the differential value having a positive value and a negative value, respectively, of a first threshold value is effected and a signal is supplied only when the respective positive or negative values of the threshold value are exceeded or not reached respectively, the outputs of the comparator circuits being connected to an input of two AND-circuits at whose second inputs a signal corresponding to the white or black value, respectively, is present, the outputs of the AND-circuits being connected to an input of an OR-circuit, whose output is connected via a pulse width discriminator to the first input of a further AND-circuit, a circuit for forming differential and absolute values whose inputs are connected to the input of the first picture store and to the output of the second picture store and whose output is connected to the input of an comparator circuit via a low-pass filter, for comparison which a second threshold value and a signal is supplied only when this threshold value is exceeded, that the output of the comparator circuit is connected via a H/V-min-filter and a H/V-max-filter to the inverting second input of the AND-circuit, at whose output the control signal is available.

10. A circuit as claimed in Claim 9, in which the pulse width discriminator includes an AND-circuit, at whose first input the output signal whose propagation time has been adapted from the OR-circuit is present, and whose second, inverting, input is connected to the output of a H/V-median filter, whose input is connected to the output of the OR-circuit

11. A method of removing noise signals from video signals by means of adaptive median filtering substantially as described herein with reference to the accompanying drawings.

12. A circuit for removing noise signals from video signals by means of adaptive median filtering substantially as described herein with reference to the accompanying drawings.

13. Any novel feature or novel combination of features disclosed herein whether explicitly or implicitly whether or not it relates to the same invention as that claimed in any preceding claim.

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Examiner's report to the Comptroller under Section 17
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Search Examiner
MR J M MCCANN

Date of completion of Search
20 FEBRUARY 1995

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) WPI

Documents considered relevant following a search in respect of Claims :-
1

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Category	Identity of document and relevant passages	Relevant to claim(s)
X	WO 94/09592 (ACCOM INCORPORATED) see whole document	1

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